Geologic Resource Evaluation Scoping Summary
John Muir National Historic Site

Prepared by Katie KellerLynn
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Geologic Resources Division
National Park Service
U.S. Department of the Interior

The Geologic Resource Evaluation (GRE) Program provides each of 270 identified natural area National Park System units with a geologic scoping meeting and summary (this report), a digital geologic map, and a geologic resource evaluation report. The purpose of scoping is to identify geologic mapping coverage and needs, distinctive geologic processes and features, resource management issues, and potential monitoring and research needs. Geologic scoping meetings generate an evaluation of the adequacy of existing geologic maps for resource management, provide an opportunity for discussion of park-specific geologic management issues, and if possible include a site visit with local experts.

The National Park Service held a GRE scoping meeting for John Muir National Historic Site on September 24, 2008, at park headquarters. Resource Manager Lucy Lawliss welcomed the group and provided a brief overview of the resources at the national historic site. Russ Graymer (U.S. Geological Survey) outlined the geologic framework for the historic site, including rock units and faults. Tim Connors (Geologic Resources Division) facilitated the assessment of map coverage, and Bruce Heise (Geologic Resources Division) led the discussion regarding geologic processes, features, and related management issues. Participants at the meeting included NPS staff from John Muir National Historic Site, Golden Gate National Recreation Area, San Francisco Bay Area Network, Columbia Cascades Support Office, Pacific West Region, and Geologic Resources Division, and cooperators from the California Geological Survey, U.S. Geological Survey, and Colorado State University (table 1).

Park and Geologic Setting

Located in Martinez, California, and established in 1964, John Muir National Historic Site preserves the Victorian home of the noted author and preservationist for whom the site was named. Muir spent many hours in the “scribble-den” upstairs, where books lined the walls and papers lay strewn over every available surface (Rubissow 1990). Muir and his writings played a major role in preserving many National Park System units, including Yosemite, Sequoia-Kings Canyon, Grand Canyon, Mt. Rainier, and Petrified Forest (Rubissow 1990). Muir married Louie Strentzel in 1880. Her family owned and operated a 1,050-ha (2,600-ac) ranch in the Alhambra Valley. John Muir went into partnership with his father-in-law, Dr. John Strentzel, and for 10 years directed most of his energy into managing this large fruit ranch (http://www.nps.gov/jomu/faqs.htm). John Muir National Historic Site is just a small piece of the original ranch. In addition to 4 ha (9 ac) of fruit orchards, where the Muir House and Martinez Adobe are located, the national historic site also includes 132 ha (326 ac) of oak woodland in an area called Mt. Wanda (named for Muir’s elder daughter), and the John and Louie Strentzel Muir gravesite property. All of these resources commemorate Muir’s life and contributions to conservation.

During scoping Russ Graymer (U.S. Geological Survey) described two rock units that define the general area around and including John Muir National Historic Site: the Great Valley Complex and the Franciscan Complex. The Great Valley Complex formed when the Farallon and North American plates collided during the Mesozoic Era (251–65.5 million years ago). This collision occurred before the Farallon Plate was completely subducted (and replaced by the Pacific Plate) and before transform plate movement replaced convergent plate movement (resulting in the San Andreas Fault system). The Great Valley Complex originated in a marine fore-arc basin, between the subduction trench and the volcanic arc.

Many geologists would say that the Franciscan Complex is the most interesting of all Bay Area rocks and come from all over the world to study them (Sloan 2006). These rocks formed in several plate tectonic settings, many far from their present location, rafting to California on moving plates. Pillow basalts, radiolarian chert, graywacke sandstone/shale, and metamorphic rocks (altered during subduction) are the most common Franciscan rocks.

Bedrock exposures are limited in John Muir National Historic Site (Elder et al. 2007). Rocks of the Great Valley Sequence—one of two members of the Great Valley Complex—underlie most of the Mt. Wanda area. Two unnamed sandstone units of the Great Valley Sequence are present. The first—unit Kus in Graymer et al. (1994)—consists of sandstone, siltstone, and shale. This is overlain by unit Kcs, described as "gray, massive quartz arenite" (Graymer et al. 1994). Arenite is well-sorted, "clean" sandstone. Both of these rock units lie at the top of the Cretaceous sequence in the area. Additionally the Paleocene Vine Hill Sandstone—specifically the lower glauconitic (characteristically green) sandstone member—probably underlies the house area of the historic site and a small area on the north flank of Mt. Wanda. Presumably the Franciscan Complex underlies all of Contra Costa County (Graymer et al. 1994).

Geologic Mapping for John Muir National Historic Site

During the scoping meeting, Tim Connors showed some of the main features of the GRE Program's digital geologic maps, which reproduce all aspects of paper maps, including notes, legend, and cross sections, with the added benefit of being GIS compatible. The NPS GRE Geology-GIS Geodatabase Data Model incorporates the standards of digital map creation for the GRE Program and allows for rigorous quality control. Staff members digitize maps or convert digital data to the GRE digital geologic map model using ESRI ArcMap software. Final digital geologic map products include data in geodatabase, shapefile, and coverage format; layer files; FGDC-compliant metadata; and a Windows HelpFile that captures ancillary map data. These data are posted at http://science.nature.nps.gov/nrdata/. The data model is available at http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm.

When possible, the GRE Program provides large scale (1:24,000) digital geologic map coverage for each park's area of interest, which is often composed of the 7.5-minute quadrangles that contain park lands. Maps of this scale (and larger) are useful to resource managers because they capture most geologic features of interest and are spatially accurate within 12 m (40 ft). The process of selecting maps for management begins with the identification of existing geologic maps and mapping needs in the vicinity of the park. Scoping session participants then select appropriate source maps for the digital geologic data or develop a plan to obtain new mapping, if necessary.

In compiling the digital map for John Muir National Historic Site, GRE staff will use a combination of paper maps and Mylar scans from the California Geological Survey, in particular Open-File Report 95-12, which shows landslide and debris-flow deposits. "GMAP" numbers shown here are unique identification numbers for the GRE Program's database.

Haydon, W. D. 1995. Geologic map of the Martinez-Orinda-Walnut Creek area, Contra Costa County, California [GMAP 46594]. In *Landslide Hazards in the Martinez-Orinda Walnut Creek Area, Contra Costa County, California*. Scale 1:24,000. Landslide Hazards Identification Map 32. Open-File Report OFR 95-12, Plate 32c. Sacramento, CA: California Geological Survey.

Haydon, W. D. 1995. Landslides and related slope-failure features map of the Martinez-Orinda-Walnut Creek area, Contra Costa County, California [GMAP 46592]. In *Landslide Hazards in the Martinez-Orinda Walnut Creek Area, Contra Costa County, California*. Scale 1:24,000. Landslide Hazards Identification Map 32. Open-File Report OFR 95-12, Plate 32b. Sacramento, CA: California Geological Survey.

Haydon, W. D. 1995. Relative debris-flow susceptibility map of the Martinez-Orinda-Walnut Creek area, Contra Costa County, California [GMAP 46593]. In *Landslide Hazards in the Martinez-Orinda Walnut Creek Area, Contra Costa County, California*. Scale 1:24,000. Landslide Hazards Identification Map 32. Open-File Report OFR 95-12, Plate 32d. Sacramento, CA: California Geological Survey.

Haydon, W. D. 1995. Relative landslide susceptibility map of the Martinez-Orinda-Walnut Creek area, Contra Costa County, California [GMAP 46591]. In *Landslide Hazards in the Martinez-Orinda Walnut Creek Area, Contra Costa County, California*. Scale 1:24,000. Landslide Hazards Identification Map 32. Open-File Report OFR 95-12, Plate 32a. Sacramento, CA: California Geological Survey.

As of April 2008, GRE staff is in the process of digitizing these maps and expects to be completed by the end of fiscal year 2008 (Tim Connors, Geologic Resources Division, e-mail communication, April 11, 2008).

Geologic Features, Processes, and Resource Management Issues

The scoping session at John Muir National Historic Site provided an opportunity to develop a list of geologic features, processes, and related resource management issues, which will be further explained in the final GRE report. During scoping, participants did not prioritize the issues, but discussion made it clear that seismicity and fluvial features and processes have high management significance. These are discussed first, followed alphabetically by other features and processes of interest.

Seismicity

According to Graymer et al. (1994), broadly distributed transpressional faults (i.e., strike-slip faults that have a component of shortening) dominate the structure of Contra Costa County. Most of the faults have been active in the Quaternary (1.8 million to 11,500 years ago). The Southampton and Concord faults are within a mile of the national historic site, but the Hayward Fault, a major branch of the San Andreas Fault, provides the major shaking potential to the area (see Herd 1978 and Lienkaemper 1992). For instance, the 1868 Hayward earthquake was the first great “San Francisco earthquake” and one of the most damaging earthquakes in the nation’s history (see http://1868alliance.org/). The Concord Fault is a known “bad actor” with an annual creep rate of 3–4 mm (0.12–0.16 in) (Borchardt and Baldwin 2001). According to Russ Graymer (U.S. Geological Survey), the creep rate on the Southampton Fault is more controversial and much debated in the seismic community. Though suspected by some to be a “bad actor” with a creep rate of up to 6 mm (0.25 in) per year, others believe the Southampton Fault is inactive.

Faults provide a cultural context for John Muir National Historic Site. According to Rubissow (1990), “after the 1906 earthquake cracked one of the marble fireplaces, Muir replaced it with a brick-lined cavern big enough to hold a real mountain campfire.” Historically interesting, events such as these also show the vulnerability of the structures at the national historic site to seismicity. During shaking, houses can move off foundations and tall chimneys can fall; adobe walls turn to dust. The cripple wall—a short wooden wall framed between the foundation and floor—of the “Big House” could collapse. Many architectural themes with high-profile styles, such as Victorian homes in Hollister, require cripple-wall construction to attain desired design height (http://www.expertwitness.com/prof/construction-expert-witness/13661.htm).

Fluvial Features and Processes

Alhambra Creek flows through the Muir gravesite property and is steadily incising and eroding its banks. In order for the creek to overflow its banks, a 100- to 500-year flood is required. Hence the greater concern is the gradual undercutting of the bank so close to the gravesite. In the orchard area, Franklin Creek floods and transports debris, which is a management concern. In the Mt. Wanda area, sheetwash causes erosion and flooding downstream. Eroded debris from Mt. Wanda fills the stream channel.

Climate Change

“A climate disrupted by human activities poses such sweeping threats to the scenery, natural and cultural resources, and wildlife of the West’s national parks that it dwarfs all previous risks to these American treasures,” so states *Losing Ground: Western National Parks Endangered by Climate Disruption* (Saunders et al. 2006). The authors contend that “a disrupted climate is the single greatest threat to ever face western national parks.” Because of the potential disruption that climate change could cause to park resources, including geologic features and processes, the GRE Program has begun to include a discussion of the effects of climate change to park resources as part of scoping meetings. At 43 m (140 ft) above sea level, John Muir National Historic Site will probably not be affected by the effects of sea-level rise such as marine inundation. However, predictions of intensified climatic variability, winter storms, and hotter, dryer summers could affect plant species and vegetation communities, the recurrence and severity of wildfires, and sedimentation and erosion rates.

Disturbed Lands

Modern human activities have disturbed more than 127,480 ha (315,000 ac) in 195 National Park System units. Some of these features may be of historical significance, but most are not in keeping with the mandates of the National Park Service. Disturbed lands are those park lands where the natural conditions and processes have been directly impacted by mining activities, development (e.g., facilities, roads, dams, abandoned campgrounds, and user trails), agricultural practices (e.g., farming, grazing, timber harvest, and abandoned irrigation ditches), overuse, or inappropriate use. Usually lands disturbed by natural phenomena such as landslides, earthquakes, floods, hurricanes, tornadoes, and fires are not considered for restoration unless influenced by human activities. Disturbed lands at John Muir National Historic Site include grazed areas near Mt. Wanda, which has led to gullying. Grazing ended in 1996. Additionally fire roads around Mt. Wanda have caused enhanced erosion.

Restoration activities return the quality and quantity of an area, watershed, or landscape to some previous condition, often some desirable historic baseline. To accelerate site recovery, restoration at disturbed areas directly treats the disturbance and aims to permanently resolve the disturbance and its effects. For more information about disturbed lands restoration, contact Dave Steensen (Geologic Resources Division) at dave_steensen@nps.gov or 303-969-2014.

Hillslope Features and Processes

As stated in Graymer et al. (1994), landslides are intentionally omitted from the preliminary geologic map of Contra Costa County because they are so numerous they would conceal much of the information on bedrock geology. In general, USGS bedrock geologists deliberately do not include landslide deposits on their maps. According to Chris Wills (California Geological Survey), the landslides shown on bedrock maps are often less than 20% of the actual coverage.

Because Mt. Wanda is the highest point in the local area, hillslope features and processes are concentrated here: The Cretaceous (145.5–65.5 million years ago) sandstone and shale are prone to landsliding, and debris flows are common. Park and network staffs have proposed a study that would test the ability of native vegetation (e.g., grasses) to slow erosion and prevent slope failure on Mount Wanda (Moore 2006). Lack of funding is postponing such a study, however.

Paleontological Resources

Will Elder (Golden Gate National Recreation Area) conducted a preliminary inventory of the paleontological resources in the San Francisco Bay Area Network. Elder attended the scoping meeting for John Muir National Historic Site and informally presented his findings. The following information is from Elder et al. (2007): No fossils are known from the Cretaceous rocks exposed at John Muir National Historic Site, but rocks of similar age nearby have produced diverse invertebrate and microfossils. Weaver (1949) lists diverse molluscan assemblages at several localities slightly north of the national historic site, possibly lying in the upper sandstone unit (Kus) of the Great Valley Sequence. In all likelihood the predominately sandstone units at John Muir National Historic Site are too coarse to yield good microfossil assemblages; nevertheless, only 0.8 km (0.5 mile) southwest of the national historic site, a siltstone and shale layer occurring between the upper (Kus) and lower (Kcs) sandstone units of the Great Valley Sequence has yielded diverse foraminiferal fauna of Upper Campanian age (E. Brabb, U.S. Geological Survey, geologist emeritus, personal communication to Will Elder, 2006). Thus, good potential exists for Cretaceous invertebrate and microfossil resources within John Muir National Historic Site. Plant, pollen, and trace fossils are also likely to be present in the Great Valley Sequence exposed at the site.

Rocks of Paleocene (65.5–55.8 million years ago) age are very rare in California. The rocks of this age in the Martinez area provided important fossil material for documenting the first fossils known from this period on the West Coast (Elder et al. 2007). Studies of these fossils include some of the pivotal early work dating back to Gabb (1869), and including White (1889), Stanton (1896), Dickerson (1914), Nelson (1925), and Watson (1942). Weaver (1949) lists several localities that contain relatively diverse invertebrate faunas from what is now called the Vine Hill Formation. Although no fossils are known from these rocks in the national historic site, the potential exists. The deposits in the site may be too coarse for microfossils, which have been found in some finer-grained portions of the Vine Hill Formation to the east of the national historic site (Weaver 1949).

Unique Geologic Resources

Unique geologic resources may include the following: natural features mentioned in a park's enabling legislation, features of widespread geologic importance, geologic resources of interest to visitors, and geologic features worthy of interpretation. The GRE Program also considers type localities and age dates as unique geologic resources. As mentioned in the "Paleontological Resources" section in this summary, Paleocene rocks are rare in California; hence, their occurrence in the Martinez area is significant and worth interpreting for visitors. The type section of the Paleocene Vine Hill Formation is within a few miles of the national historic site.

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Table 1. Scoping Meeting Participants for John Muir National Historic Site

Name	Affiliation	Position	Phone	E-Mail
Tim Connors	Geologic Resources Division	Geologist	303-969-2093	tim_connors@nps.gov
Marsha Davis	Columbia Cascades Support Office	Geologist	206-220-4262	Marsha_Davis@nps.gov
Will Elder	Golden Gate National Recreation Area	Interpreter	415-561-4326	will_elder@nps.gov
Russ Graymer	U.S. Geological Survey	Geologist	650-329-5028	rgraymer@usgs.gov
Bruce Heise	Geologic Resources Division	Geologist/GRE Program Coordinator	303-969-2017	bruce_heise@nps.gov
Katie KellerLynn	Colorado State University	Geologist/Research Associate	801-608-7114	katiekellerlynn@msn.com
Marcus Koenen	San Francisco Bay Area Network	Network Coordinator	415-342-9100	marcus_koenen@nps.gov
Lucy Lawliss	JOMU, EUON, RORI, POCH	Resource Manager	510-232-1544	lucy_lawliss@nps.gov
Greg Mack	Pacific West Region	Geologist	206-220-4249	gregory_mack@nps.gov
Bonnie Murchey	U.S. Geological Survey	Geologist	650-329-4926	bmurchey@usgs.gov
Phil Stoffer	U.S. Geological Survey	Geologist	650-329-5028	pstoffer@usgs.gov
Chris Wills	California Geological Survey	Geologist	916-323-8553	cwills@consrv.ca.gov